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Biofuels Production from Renewable Resources

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Editorial to the BAB Special Issue: “Biofuels Production from Renewable Resources”

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Biofuels are emerging as the most important alternative to petroleum-derived transportation fuels and biomasses are the primary source of renewable energy for the production of chemicals and fuels. The term biomass refers to organic matter deriving from various feedstock such as wood and other lignocellulose-containing low-value biomasses, agricultural crops and other green wastes, animal wastes, aquatic plants and wastes. Biofuels can be solid, liquid or gas fuels. A variety of processes that exploit the transformation of a suitable biomass into a higher added value product are now available. The main advantages of producing and using biofuels are that these raw materials are generally available in many different areas of the world and that they generate low net greenhouse gas emissions, therefore minimizing the environmental impact.

In this special issue we will focus on four key determining aspects of biofuels production from renewable resources. 1) Innovative processes for the production of bioethanol, butanol and methane; 2) New enzymatic technologies for the modification of lignocellulose matrices; 3) The role of positive and negative modulators on biofuel production; and 4) the recovery of other value-added products from biofuel-producing wastes.

1) Innovative processes for the production of bioethanol, butanol and methane.

Oil palm empty fruit bunch (OPEFB) is a biomass obtained in palm oil mills that can be an important resource of fuels and chemicals. Zhai et al. [1] demonstrate the feasibility of an innovative integrative process that includes dilute alkaline pretreatment, cellulolytic enzyme production, OPEFB hydrolysis and co-fermentation with a hybrid xylose-fermenting yeast. Their work opens new perspectives for the use of OPEFB biomass to produce ethanol. On the same matrix (palm empty fruit bunches or EFB), Campioni et al. [2] propose an integrated biorefinery process. This approach exploits a sequence of steps involving chemical pretreatment, enzymatic saccharification and glucose fermentation in a separate hydrolysis and fermentation. The hydrolysate was employed in bioethanol production by a new isolate *Candida pelliculosa* CCT 7734.

Narayanasamy et al. [3] report acetone–butanol–ethanol (ABE) fermentation of sugarcane bagasse (SCB) hydrolysate using *Clostridium beijerinckii* strains. The authors developed a cost-effective SCB medium that does not require enzymatic hydrolysis, supplementation of extra carbon sources or expensive nitrogen sources. The data demonstrate a high potential for the developed cost-effective medium in biofuel production. The medium could also be potentially used for production of other value-added chemicals.

Hong et al. [4] propose a methodology for the production of biobutanol from red algal biomass. Using a diluted sulfuric acid and a newly isolated *Clostridium* sp. strain WK they present a new and efficient way to produce biobutanol from marine biomass feedstock, exploiting the potential of the so called “blue” bioeconomy.

Methanogens are responsible for the last step in anaerobic digestion in which methane, a gas biofuel, is produced. Since methanogens are known to be co-metabolizers of chlorinated pollutants, Paulo et al. [5] focused their work on the effect of nickel, cobalt and iron on the growth of *M. barkeri*. The data show

how metal addition improves 1,2-dichloroethene dechlorination to vinyl chloride, indicating that metal ions can be a limiting factor in methanogenesis and dechlorination.

2) New enzymatic technologies for the modification of lignocellulose matrices.

Increasing demand of biomass-derived biofuels could cause a shift of production of food crops to biofuels crops, thus posing serious ethical questions. Indeed, lignocellulosic material could become an attractive substrate for biofuels production because of its extensive production and low cost, making it the most abundant and least used resource of fuels and raw materials. Increased efficiency of lignin exploitation is linked to improved enzyme-based degradation.

In their review, Catucci et al. [6] underline the importance of lignocellulose as a biomass source in the general context of an increased energy demand. They stress the potential use of a specific class of enzyme, dye-decolorizing peroxidases (DyP) in lignin degradation. The review envisions the improvement of the activity of DyPs against lignin to reach satisfactory conversion levels for industrial applications. In line with the requirements for sustainable scale-up, Akpinar and Urek [7] used cherry waste (CW) collected from industry as substrate and *Pleurotus eryngii* as the microorganism to increase production of lignocellulolytic enzymes such as laccase (Lac), manganese peroxidase (MnP), lignin peroxidase (LiP), carboxymethyl cellulase (CmCase), xylanase, exoglucanase, β -glucosidase (BGLA). The data show that *P. eryngii* adapted to all solid-state fermentation conditions and resulted in increased enzymatic activities that also demonstrated decolorizing performance. Dillies et al. [8] reported on three laccase mediator systems (LMS) to depolymerize the major industrial lignins (organosolv lignin, Kraft lignin, and sodium lignosulfonate). Their data show that enzymatic depolymerization of these lignins can be achieved by LMS using laccase from

Trametes versicolor, a mediator and a cosolvent to enhance the solubilization of lignins.

3) The role of positive or negative modulators on biofuel production

Several different chemical or physical agents can act as positive or negative modulators of biofuels production. They can exert a role on the growth of the microorganism or directly on the activity of a specific enzyme.

Cheng et al. [9] present the effects of different concentrations of a negative modulator, the simulated flue gas, onto algal growth. Photosynthetic activities were evaluated for both *Chlorella sp. AE10* and *Chlorella sp. Cv*. The data indicate that *Chlorella sp. Cv* can tolerate full simulated flue and could be used for CO₂ fixation from the simulated flue gas.

In their paper, Wang et al. [10] investigate the effect of negative modulators such as formic acid, coumaric acid, and furfural on acetone–butanol–ethanol (ABE) production from corn stover hydrolysate by *Clostridium acetobutylicum CICC 8016*. Correlation analysis revealed that formic acid, coumaric acid and total phenols were the major compounds inhibiting ABE production. The data show how a successful mitigation strategy for removal of the inhibitors can be achieved via absorption with resin D301, leading to enhanced ABE production.

Crop residue and animal manure at different value chain levels are only partially made a commodity for biofuel production with significant negative impacts on the global sustainability of the agriculture sector. Bello et al. [11] tested Biochar addition, within cattle manure composting process, as a positive modulator in the nitrogen transformation process. The results indicate that Biochar addition accelerated organic matter degradation and improved nitrogen mineralization.

4) The recovery of other value products from biofuels-producing waste

D-Psicose is a value-added product that can often be obtained from biomass sources that are employed for biofuels production. D-Psicose 3-epimerase is an enzyme that catalyzes the synthesis of D-psicose from D-fructose. In their study, Fu et al. [12] cloned the D-psicose 3-epimerase (RDPE) from *Ruminococcus sp.* and expressed it in *Bacillus subtilis A311*. RDPE expression was increased using a two-step pH regulation of segmented fermentation. This system provides an important experimental basis for the industrial-scale production of RDPE.

As Guest Editors, we would like to thank all the authors for their contribution in this issue. We believe that their articles represent highly innovative recent discoveries and technology developments in biofuels production from renewable resources. We hope that their work can be helpful for both experts and newcomers of the field.

Finally, we would also like to express our gratitude to the Editors-in-Chief, Prof. Gianfranco Gilardi and Prof. Jian-Jiang Zhong, as well as the Managing Editor Gwen Taylor and the rest of the editorial team for their efforts in making this special issue possible.

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